

**RADC-TR-89-40**  
**Final Technical Report**  
**April 1989**



AD-A206 607

# **RADC PHOTONICS CENTER SUPPORT**

**Southeastern Center for Electrical Engineering Education**

**Kenneth J. Teegarden**

*APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED*

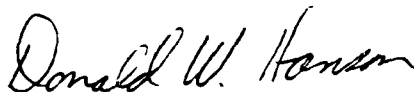
**DTIC**  
**ELECTE**  
**S** 2 APR 1989 **D**  
**E**

**ROME AIR DEVELOPMENT CENTER**  
**Air Force Systems Command**  
**Griffiss Air Force Base, NY 13441-5700**

This report has been reviewed by the RADC Public Affairs Division (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be releasable to the general public, including foreign nations.

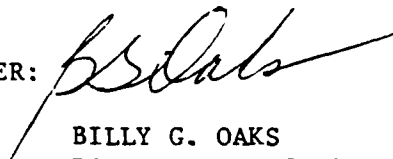
RADC-TR-89-40 has been reviewed and is approved for publication.

APPROVED:



DR. DONALD W. HANSON  
Associate Director  
Photonics Center

FOR THE COMMANDER:



BILLY G. OAKS  
Directorate of Plans & Programs

If your address has changed or if you wish to be removed from the RADC mailing list, or if the addressee is no longer employed by your organization, please notify RADC ( OP ) Griffiss AFB NY 13441-5700. This will assist us in maintaining a current mailing list.

Do not return copies of this report unless contractual obligations or notices on a specific document require that it be returned.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

## REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION N/A			1b. RESTRICTIVE MARKINGS N/A		
2a. SECURITY CLASSIFICATION AUTHORITY N/A			3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) N/A			5. MONITORING ORGANIZATION REPORT NUMBER(S) RADC-TR-89-40		
6a. NAME OF PERFORMING ORGANIZATION Southeastern Center for Elec- trical Engineering Education		6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION Rome Air Development Center		
6c. ADDRESS (City, State, and ZIP Code) Central Florida Facility 1101 Massachusetts Avenue St. Cloud, Osceola County, FL 32769			7b. ADDRESS (City, State, and ZIP Code) Griffiss AFB NY 13441-5700		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Rome Air Development Center		8b. OFFICE SYMBOL (If applicable) OP	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER F30602-81-C-0193		
8c. ADDRESS (City, State, and ZIP Code) Griffiss AFB NY 13441-5700			10. SOURCE OF FUNDING NUMBERS		
PROGRAM ELEMENT NO. 62702F		PROJECT NO. 4519	TASK NO. 21	WORK UNIT ACCESSION NO. P6	
11. TITLE (Include Security Classification) RADC PHOTONICS CENTER SUPPORT					
12. PERSONAL AUTHOR(S) Kenneth J. Teegarden					
13a. TYPE OF REPORT Final		13b. TIME COVERED FROM Jun 87 TO Sep 88		14. DATE OF REPORT (Year, Month, Day) April 1989	
15. PAGE COUNT 12					
16. SUPPLEMENTARY NOTATION N/A					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
20	06	01	Photonics, Optics		
25	05				
19. ABSTRACT (Continue on reverse if necessary and identify by block number)  Project Forecast II identified photonics as a high leverage technology of great importance to future Air Force systems. Rome Air Development Center (RADC) was appointed as the lead Air Force laboratory for photonics by AFSC. This led to the establishment of the Air Force Photonics Center at RADC. This report describes the initial activities of establishing the Photonics Center including selection of technical thrusts, staffing, and operational concepts.					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a. NAME OF RESPONSIBLE INDIVIDUAL Donald W. Hanson			22b. TELEPHONE (Include Area Code) (315) 330-4365		22c. OFFICE SYMBOL RADC (OP)

DD Form 1473, JUN 86

Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE  
UNCLASSIFIED

## INTRODUCTION

An extensive study of the future technological needs of the Air Force, called "Forecast Two", identified photonics as being critical to the development of new systems essential to the defense of this country. In response to the conclusions of this study, the Air Force Systems Command designated the Rome Air Development Center as the Air Force's lead laboratory in photonics. The then Commander of RADC, Col. Charles E. Franklin, established the Photonics Center at RADC at the Directorate or Divisional level as the best way of exploiting this new technology for the benefit of the Air Force. The Photonics Center was to develop and maintain an inhouse research program and coordinate the photonics related activities of RADC. In order to attract both the quality and quantity of researchers needed for an inhouse program, the Center was to develop collaborative research activities with academic and industrial laboratories to be carried out at RADC. The intent of these collaborative activities was to create a mix of industrial, academic, and government researchers working together in the Photonics Center towards common goals set by the Center.

On June 30, 1987 Kenneth J. Teegarden was retained, under RADC's Expert in Science program, to assist in planning the program of the Photonics Center during his leave of absence from the University of Rochester. The work was initiated under task C-7-2134 of this contract. After June 21, 1988 it was continued under task P-8-0011, which terminated on September 30, 1988. During the latter period Col. Raymond A. Shulstad was Commander of RADC.

## THE TECHNICAL PROGRAM OF THE PHOTONICS CENTER

Initial planning for the research activities of the Center revealed a critical need for work which moves the results of basic research programs in photonics into the applied domain, especially in situations where critical limitations in current electronic technology can be removed by the application of photonics. A well known example of a situation where a bottle neck in electronic technology has been removed by the utilization of photonic technology is the use of optical fibers to replace electronic conductors in telephone systems. Another need at RADC is to evaluate and integrate the results of an extensive contract program in photonics into systems designed to carry out the communications and intelligence gathering missions of the Directorates.

The first task of the contractor was to determine the technical focus of the inhouse research program relative to Air Force and RADC needs. To accomplish this, a thorough review of ongoing photonics activities being carried out by the mission Directorates was undertaken. This review was accomplished with the invaluable assistance of Dr. Bruno Beek, then Technical Director of the Communications Directorate at Griffiss Air Force Base. It occupied the first three months of the contract period and resulted in the conclusion that the RADC mission of providing technological support in the areas of intelligence gathering and communications could best be served by an inhouse research program that emphasized the application of photonics to communications and electromagnetic signal processing. A large part of the technological activity at RADC involves the processing and storage of radar data by electronic means, with computers, of course, playing a major role in the activity. As well as

promising higher speed and throughput, photonics holds out the possibility of the very rapid storage and retrieval of information in massive archival memories, a bottle neck for electronic computers. Also, the utilization of the very high band width of optical waveguides in the rapid transmission of information between electronic or optical computers is a critical role for photonics technology. These considerations lead to the identification of four major areas as the initial inhouse program of the Photonics Center. They are: 1. Analog and Digital Optical Processing, 2. Digital Optical Computers, 3. Optical Fiber Microwave Links, and 4. Optical Memories. It should be noted that in each case hybrid electro-optical systems will be the rule, with the role of photonics evolving as experience with this new technology is gained.

A detailed research program for the Center was written and submitted for the approval of the Commander and Chief Scientist of RADC.

#### STAFFING THE PHOTONICS CENTER

The charter of the Photonics Center placed a strong emphasis on the participation of scientists and engineers from industrial and university laboratories in its inhouse research program. Initial planning for the Center anticipated that 50% of its active research staff would be drawn from these sources. The rationale to involve outside researchers was based partly on the need to supplement the limited number of government positions available for the Center's expansion. In addition, however, it was felt that such a plan would result in strong, continuing links to a spectrum of ongoing research transcending the geographical bounds of the Photonics Center. Collaborative inhouse research can result in access to research laboratories whose activities supplement the activities of the Center and leverage a much broader range of applied research and engineering that can be supported directly by the Air Force.

It was felt that such collaborative research with Universities could best be achieved by working with established agencies whose primary mission was the support of University based research. An arrangement whereby research carried out by University faculty and students would be jointly supported was discussed with the National Science Foundation. Under this arrangement research proposals which received excellent ratings in NSF's normal review process would be jointly funded by NSF and RADC provided part of the work was carried out at RADC by University faculty and students. A Memorandum of Understanding to this effect was prepared and submitted to the Commander and the Chief Scientist of RADC for their approval. Similar discussions were held with appropriate divisions of the Air Force Office of Scientific Research. As a result of these discussions, researchers at major universities already supported by the Air Force through AFOSR were identified. Initial contacts to determine how this research supports Photonics Center objectives have been made. Developing collaborative arrangements of benefit to the Photonics Center in these cases should be relatively simple since the Air Force already supports the work.

A similar link with industrial laboratories was also sought. Several discussions with industrial research groups were held. In each case the opportunity to have a researcher from the industrial group working at the Photonics Center in areas of mutual interest was offered. Considerable enthusiasm, stemming partly from the possibility of sharing the resources of RADC and partly from the obvious advantage of close contact with its contract

activities, was encountered in these discussions. An arrangement with Eastman Kodak Company was achieved and an engineer from that company's Federal Systems Division is currently working part time in the Photonics Center. It is clear that one of the requirements for the expansion of collaborative research with industry is the development of a blanket agreement covering patent rights and licensing. An agreement of this kind was prepared and submitted to the Judge Advocate for his consideration.

An attempt to interest the State of New York in a joint effort to exploit photonic technology in a way which would encourage the growth of new industry in the Rome-Utica area absorbed a considerable fraction of the time spend under this contract. This effort resulted in a proposal to the Urban Development Commission from Oneida County for funding of a building adjacent to RADC which would house the Photonics Center and provide incubation space for emerging photonics based industry. The details of this plan can be obtained from the proposal.

#### SUMMARY AND RECOMMENDATIONS

Work under this contract lead to the establishment of the Air Force Photonics Center at Griffiss Air Force Base. Considerable progress was made towards achieving the national prominence originally envisioned for this Center of Excellence in photonics. If this progress is to continue, it is of extreme importance to maintain and build the programs which have a high visibility on a national scale. These are the programs which were designed to establish collaborative activities with industry and academia. Implementation of joint support of research with NSF and AFOSR are immediate actions which should be taken, along with finalization of a document covering the rules for collaborative research with industry. Unless the initial promise of the Photonics Center is achieved, serious damage will be done to this important Air Force initiative. Contact by Photonics Center staff with outside users of photonics technology is desperately needed to give continuing direction to the inhouse photonics program and establish outside sources of support which will amplify internal funding. DARPA and AFOSR have already been approached with these objectives in mind. Again, these initial actions need to be followed up immediately to avoid misunderstanding of Air Force resolve to follow through on a highly regarded initiative.

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	



# MISSION of *Rome Air Development Center*

*RADC plans and executes research, development, test and selected acquisition programs in support of Command, Control, Communications and Intelligence (C<sup>3</sup>I) activities. Technical and engineering support within areas of competence is provided to ESD Program Offices (POs) and other ESD elements to perform effective acquisition of C<sup>3</sup>I systems. The areas of technical competence include communications, command and control, battle management information processing, surveillance sensors, intelligence data collection and handling, solid state sciences, electromagnetics, and propagation, and electronic reliability/maintainability and compatibility.*